1997

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COOPERATIVE EXTENSION SERVICE

Agronomy notes

Vol. 30, No. 5, 1997

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Burley tobacco removes large amounts of potassium (K) from soil. A 2,600 pound/A cured leaf crop takes up around 200 lbs K/A/yr, with about 110 lbs of that in the leaf and 90 lbs in the stalk. Because of such a heavy demand for K, growers are concerned that applications of fertilizer K be sufficient for top production. The University of Kentucky's Soil Testing Laboratory (Division of Regulatory Services) provides a statewide soil testing service to help growers determine soil acidity and nutrient levels. The Mehlich-3 soil extractant is used by the UK lab, and soil test K values (reported as lbs K/A) are determined from this extractant and categorized as follows for burley tobacco: Very High, over 450; High, 301-450; Medium, 201-300; Low, 91-200; Very Low, less than 91. The amount of potash fertilizer (K_2O) recommended varies from 400 lbs/A for soil test K levels below 91 to 0 when soil test K levels are above 450.

In 1994, soil test K values from the 7,420 samples from tobacco fields tested at the UK lab showed that 20% tested very high (above 450) and did not require potash fertilizer based on UK's interpretation of the Mehlich-3 soil test K levels. Another 36% tested high (301 to 450 pounds/A of soil test K), getting a recommendation of 30 lbs K_2O/A at the upper end of this range and 190 lbs K_2O/A at the lower end of the range. Thirty percent of the samples tested medium in soil test K (201-300 lbs K/A), where 200 lbs K_2O were recommended at the upper end of the range and 290 lbs K_2O/A were recommended at the lower end of the range. The remaining 14% of the samples tested low or very low (below 200 lbs K/A), with a recommendation of 300 lbs K_2O/A at the high end of this range and 400 lbs K_2O at the low end.

With sulfate of potash costing about \$.25/lb of K_2O, it is important that soil test levels of K be interpreted as accurately as possible. A field experiment was conducted during 1995-1996 to determine if UK's current interpretation of soil test K for burley tobacco is adequate.

DESCRIPTION OF THE STUDY

A field was located in Pendleton County, Kentucky which tested 120 lbs/A in Mehlich-3 extractable soil K. UK's current recommendation at this soil test level would be 370 lbs K_2O/A. Soil type was Allegheny loam, 6-12% slopes. It had been in a mixed grass/legume sod for several years prior to plowing in 1995. A composite soil sample of the 0-6 inch depth from the test area showed: pH 6.2, buffer pH 6.8, and (lbs/A) P 37, K 120, Ca 2425, and Mg 106. From these soil test data, cation exchange capacity (CEC) was estimated to be 12.4 m.e., and base saturation 55%. After plowing from sod, the test area was topdressed with 150 lbs P_2O_5/A in 1995, prior to establishing the experiment. The experimental treatments tested were 0, 300, and 600 lbs K_2O/A (applied as sulfate of potash) and either 200 or 400 lbs N/A applied as ammonium nitrate and disked in just ahead of transplanting at each K_2O rate. Additionally, K_2O was applied as sulfate of potash magnesia at 600 lbs K_2O/A and 400 lbs N/A to evaluate the need for magnesium (Mg). This treatment supplied 314 lbs Mg/A. All treatments were arranged in a randomized plot design with 4 replications. Individual plot size was 14 ft (4, 42-in rows) wide x 40 ft long. The appropriate fertilizer treatment was broadcast by hand onto each plot just prior to the final disking and transplanting. For yield estimates, 30 stalks were taken from the two center rows of each plot at harvest, cured, and separated into 3 grades of leaf. Cured leaf yields from each plot were then weighed and expressed as pounds per acre. A leaf sample was taken from the center position of the stalk, tied into a hand, and graded by a USDA tobacco market grader to determine if fertilizer treatments (interaction of N and K_2O rates) affected lug leaf grade. Grade was indexed according to the procedure described by Bowman et al. (1989), whereby the greater the index, the better the grade. Each individual plot was soil sampled immediately after harvest (six, 0-6 inch cores from center of plot) for determining fertilizer treatment effects on soil test levels. After grading, the leaf sample from each plot was oven dried and ground for determination of leaf content of N, P, K, Ca, and Mg.

The experiment was continued in 1996, with no further applications of potash fertilizers since the 1995 initial applications resulted in a wide range of residual soil test K values. Phosphorus was broadcast over all plots at 96 lbs P_2O_5 and roto-tilled in prior to transplanting. Treatments for N remained the same as in 1995 except that the N rate on the 600 lb K_2O/A as sulfate of potash magnesia was dropped to 100 lbs/A. Data collected during the 2 years were analyzed for treatment effects by use of SAS procedures.

RESULTS

1995

The interacting effects of K_2O and N rates on cured leaf yield, leaf K content, and grade index are summarized in Table 1. As indicated, there was a significant cured leaf yield increase to 300 lbs K_2O/A at either 200 or 400 lbs N/A, but no further increase when the rate was increased to 600 lbs K_2O/A. Based on UK's published recommendations, 370 lbs K_2O/A would have been recommended at the initial soil test level of 120 lbs K/A. Leaf content of K increased at each level of applied K_2O. There was little effect of fertilizer treatment on leaf grade index. Table 2 summarizes the interacting effects of K_2O and N rates on leaf content of N and soil test K levels on soil samples taken at harvest. As shown, 400 N resulted in higher leaf N than 200 N. Leaf N generally decreased, however, as K_2O rate increased, due to dry matter dilution. Soil test K levels increased as K_2O rates increased, more so at 200 N and 600 K_2O.

1996

Interacting effects of residual K_2O and N rates on cured leaf yields, leaf K content, and grade index are summarized in Table 3 for 1996. Leaf yield increased with the higher residual soil test K values which carried over from the 300 and 600 lbs K_2O/A applied the previous year. There was no effect of N rate on response to residual soil test K levels. The 100 N applied to the residual soil test K from 600 lbs K_2O/A applied as sulfate of potash magnesia the previous year yielded as much as either 200 or 400 N, indicating that residual soil test K level was more important on yield in 1996 than N rate. Leaf content of K increased as residual soil test K levels increased, resulting from the previous year's application of K_2O. Higher residual soil test K levels produced leaf with a higher grade index than at low soil test K levels. Carryover soil test K levels from 300 lbs K_2O/A produced the highest grade index at either 200 or 400 N. The interacting effect of residual soil test K levels and N rates on leaf content of N and on soil test K are summarized in Table 4. There was little effect on leaf N except that 100 N was lower than 200 or 400. Residual soil test K levels generally increased as the 1995 K_2O rates increased, with N rate having no effect.

The relationship between applications of N, K_2O, and Mg additions in the spring of 1995 on various soil and plant characteristics was evaluated by regression equations, and correlation coefficients (r) are summarized in Table 6. Leaf content of N was negatively related to leaf yield both years, the relationship being significant in 1996 but not in 1995. Leaf content of N was also negatively related to leaf content of K in both years, the relationship also being significant in 1996 but not in 1995. Leaf N was also negatively associated with grade in both years but not significantly.

There was a highly significant effect of leaf content of K associated with leaf yields in 1995, following application of fertilizer K_2O, but not in 1996 as affected by the residual K effects from the previous year's application. This relationship is shown in Figure 1, where the two year's data were combined. Yields from each individual plot were expressed as a percentage of the highest yielding plot during the two years and then were expressed as "% of maximum yield." Since the 1996 residual soil test K effects from 1995 K_2O applications were so much lower than the 1995 effects, most of the plot yields in 1996 were lower than those in 1995.

The linear equation describing this two year relationship is highly significant ($r = 0.70^{**}$), with each increasing percent of leaf K being associated with a 61.88 increase in % of maximum yield. Maximum yield was attained at a leaf K content of about 5%. Leaf grade was also significantly associated with leaf K content, with higher grades associated with higher leaf K contents. A highly significant level of soil test K was associated with leaf K content for both years. This is shown in Figure 2, where results of leaf K and soil test K from each individual plot during the two year study ($n = 56$) were correlated. A quadratic equation (not shown, $r = 0.95$) was more significantly associated with this relationship than a linear relationship. However, since leaf content of K leveled off at soil test K levels of around 400 lbs K/A, the curve was broken into two segments, and the simplified linear equations were then derived for the curve on either side of the break at 400 lbs/A soil test K, and are shown in Figure 2. This relationship showed that leaf content of K increased 0.011 % for each pound increase in soil test K, but after soil test K levels reached 400 lbs/A, there was no further increase in leaf K content as soil test K levels were increased. Current UK recommendations for fertilizer K drop to zero when soil test K is 450. Soil test levels of K were strongly associated with leaf yields in 1995 but not in 1996. Leaf grade was not significantly associated with soil test K levels.

Leaf levels of Mg were not significantly related to leaf yields or leaf grade but were strongly related to soil test levels of Mg. However, soil test levels of Mg were not significantly related to leaf yield or grade.

SUMMARY

Results from this two year study strongly suggest the following:

1 - Soil test K levels of at least 400 lbs/A (Mehlich-3 extraction) were required to obtain a leaf K content of 5%, and to maximize leaf yields. This agrees closely with current UK recommendations for use of K on tobacco.

2 - It required between 300 and 600 lbs K_2O/A to increase Mehlich-3 extractable K soil test levels from 120 lbs/A in April to about 400 lbs/A in September.

3 - Residual carryover effects from a one time addition of 600 lbs K_2O/A were insufficient to maintain soil test K levels high enough (about 400 lbs/A) to produce maximum yields for two consecutive years (soil test K levels following application of 600 lbs K_2O/A dropped from around 400 at the first year's harvest following a spring application to around 160 after the second year's harvest with no further application of K_2O after the first year).

4 - Application of Mg fertilizer increased Mg soil test levels and increased levels of leaf Mg, but did not increase yields. Mehlich-3 extractable Mg increased

from about 100 lbs Mg/A to about 500 at harvest following application of 314 lbs Mg/A as sulfate of potash magnesia. Carryover effect from this resulted in soil test Mg levels of about 190 at harvest of the second year.

5 - A fertilizer N rate of 400 lbs/A did not increase yield levels or leaf grades compared to 200 lbs N/A, during the first two years burley production following sod.

6 - Application of fertilizer K_2O improved leaf grades compared to no fertilizer K_2Oat a low level of soil test K, with 300 lbs K_2O/A improving grade as effectively as 600 lbs K_2O/A.

REFERENCE

Bowman, D.T., R.D. Miller, A.G. Tart, C.M. Sasscer, Jr., and R.C. Rufty. 1989. A grade index for burley tobacco. Tobacco Sci. Vol. 18, pp 42-43. March, 1989.

ACKNOWLEDGMENT
We wish to express appreciation to Keith and Charley Herron for use of their land and for the excellent job they did in producing the two crops of burley for this experiment.

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Table 1. Effect of Potassium and Nitrogen Rates on Yield, Leaf Potassium, and Leaf Grade
Pendleton Co., KY, 1995 - Herron Farm

	Leaf Yield (lbs/A)		% Leaf K		Grade Index	
Lbs K_2O/A	200 N	400 N	200 N	400 N	200 N	400 N
0	1787 bc	1694 c	1.59 c	2.00 c	62.5 b	60.0 b
300	2353 a	2514 a	4.10 b	4.40 b	67.5 ab	72.5 a
600	2447 a	2168 ab	5.45 a	4.50 b	67.5 ab	67.5 ab
L.S.D. (.05)	428		0.72		8.8	

initial soil test K level was 120 lbs/A

Table 2. Effect of Potassium and Nitrogen Rates on Leaf Nitrogen and Soil Potassium
Pendleton Co., KY., 1995 - Herron Farm

	% Leaf N		Lbs/A Soil K	
Lbs K_2O/A	200 N	400 N	200 N	400 N
0	4.85 b	5.53 a	105 c	100 c
300	4.15 d	4.95 ab	247 bc	309 b
600	4.25 cd	4.59 bcd	536 a	345 b
L.S.D. (.05)	0.59		162	

initial soil test K level was 120 lbs/A

Table 3. Effect of Potassium and Nitrogen Rates on Yield, Leaf Potassium, and Leaf Grade
Pendleton Co., KY, 1996-Herron Farm

	Leaf Yield (lbs/A)			% Leaf K		Grade Index	
lbs K_2O/A[1]	100N[2]	200N	400N	200N	400N	200N	400N
0	--	1669d	1753cd	1.08d	1.27cd	50.5b	60.0ab
300	--	1817bcd	1887abcd	1.84bc	2.02b	70.0a	67.5a
600	2025ab	2122a	1918abc	2.72a	2.36ab	67.5a	53.75b
LSD(.05)		242		.60		13.67	

1 all the K_2O was applied before transplanting in 1995 and the initial soil test K level was 120 lbs/A. No K_2O was applied in 1996.

2 This treatment received 600 lbs K_2O and 400 lbs N/A in 1995

Table 4. Effect of Potassium and Nitrogen Rates on Leaf Nitrogen and Soil Potassium
Pendleton Co., KY, 1996 - Herron Farm

	% Leaf N			Lbs/A Soil K	
lbs K_2O/A[1]	100N	200N	400N	200N	400N
0	--	4.78a	4.74ab	89cd	80d
300	--	4.52b	4.71ab	118cd	126bc
600	4.16c	4.60ab	4.70ab	163ab	159ab
LSD(.05)		.24		38	

1 all the K_2O was applied before transplanting in 1995 and the initial soil test K level was 120 lbs/A. No K_2O was applied in 1996.

Table 5. Soil Test K Values For Two Years Following Application of Potash The First Year, At Different Nitrogen Rates. Pendleton Co., KY, 1995-1996 - Herron Farm

	Soil Test K - 1995[2]		Soil Test K - 1996[3]		
lbs K_2O/A[1]	200N	400N	100N[4]	200N	400N
0	105c	100c	192a	89cd	80d
300	247bc	309b	--	118cd	126bc
600	536a	345b	--	163ab	159ab
LSD(.05)	162			38	

1 all the K_2O was applied before transplanting in 1995 and the initial soil test K level was 120 lbs/A. No K_2O was applied in 1996.

2, 3 Soil test K (lbs/A) from samples taken at harvest, Av 4 reps/tmt.

4 The 100 N treatment was grown on plots which had received 400N and 600 K_2O in 1995.

Table 6. Relationship Between Plant and Soil Factors From Burley Production on an Allegheny Loam Soil Pendleton Co., KY, Herron Farm 1995-96

Nitrogen	1995	1996
	Correlation Coefficient	
% Leaf N vs Yield	-.34NS	-.39*
% Leaf N vs % Leaf K	-.23NS	-.38*
% Leaf N vs Grade	-.26NS	-.30NS
Potassium		
% Leaf K vs Yield	.74**	.30NS
% leaf K vs Grade	.44*	.36 (sig@.10)
% Leaf K vs Soil K	.82**	.89**
Soil K vs Yield	.51**	.23NS
Soil K vs Grade	.19NS	.25NS
Magnesium		
% Leaf Mg vs Yield	-.28NS	.21NS
% Leaf Mg vs Grade	-.33NS	.09NS
% Leaf Mg vs Soil Mg	.51**	.51**
Soil Mg vs Yield	.32NS	.25NS
Soil Mg vs Grade	.01NS	.03NS

* significant at the 95% probability level
** significant at the 99% probability level
NS non-significant

Figure 1. **The Relationship Between Content of Leaf K and Percent of Maximum Leaf Yield**

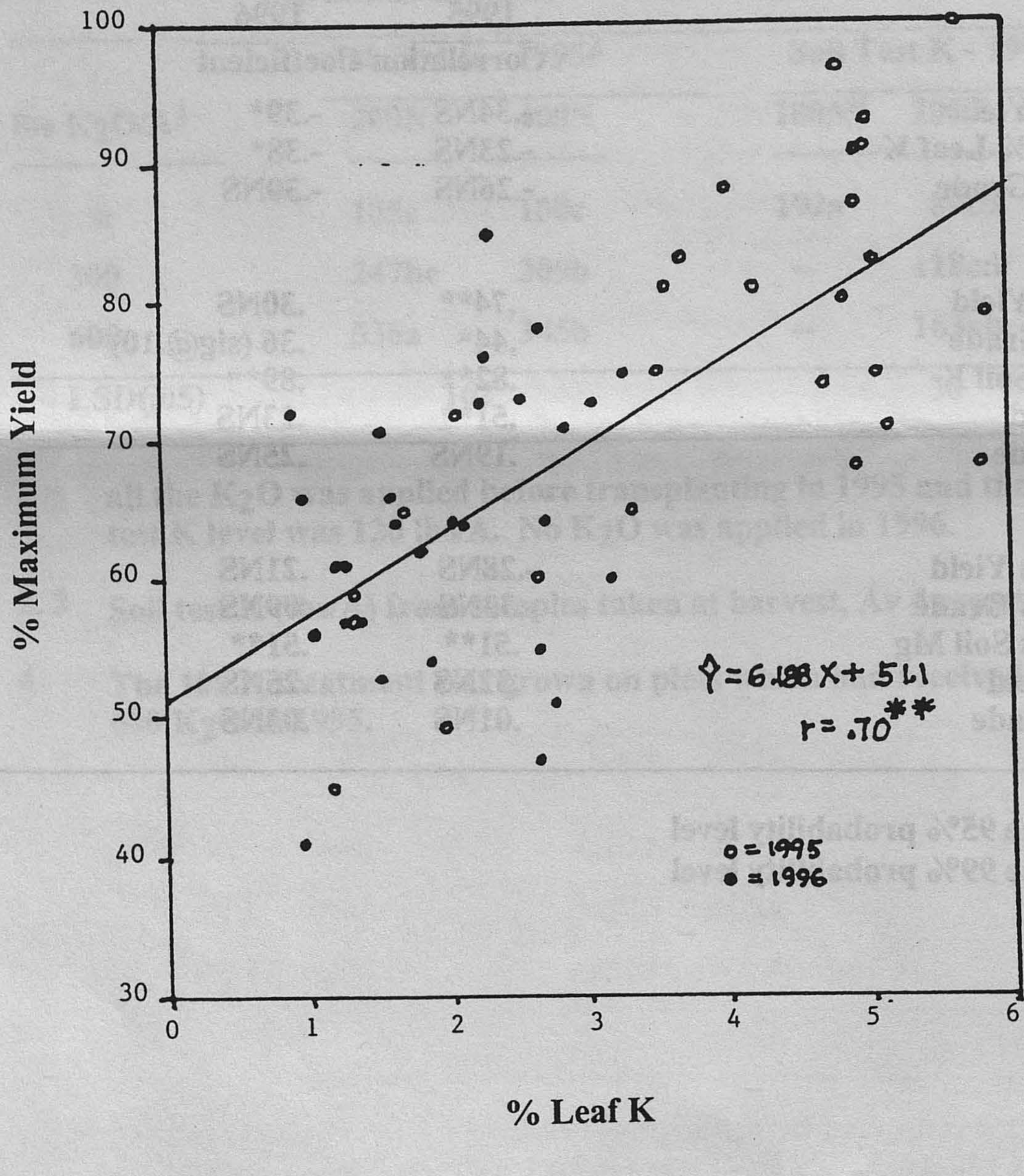
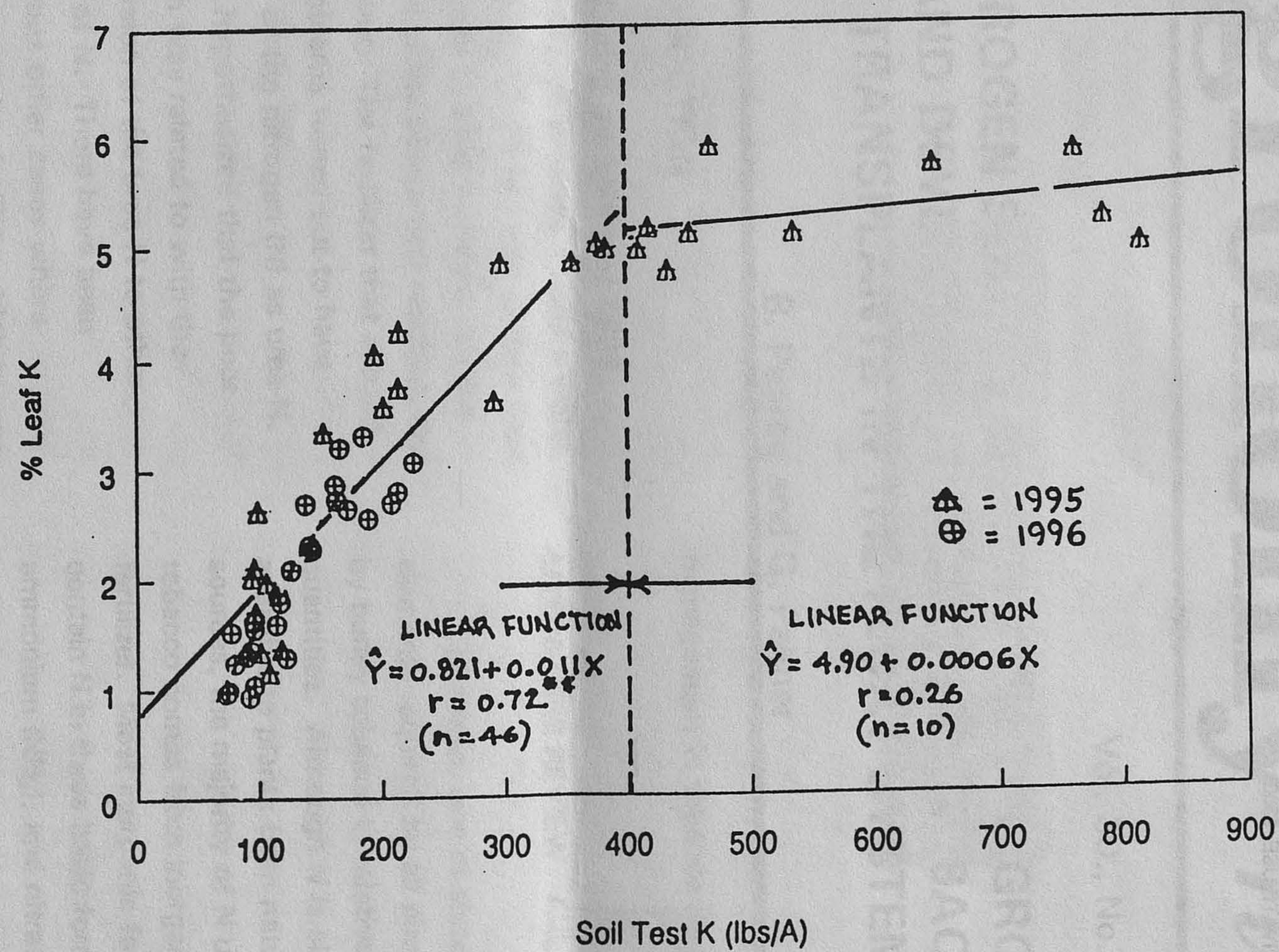


Figure 2. Effect of Soil Test K on % Leaf K of Burley Tobacco, Pendleton Co. KY 1995-96



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